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Louisiana Energy Topic

Department of Natural Resources — Technology Assessment Division

A Supplement to LOUISIANA ENERGY FACTS on Subjects of Special Interest

AMERICA'S WETLANDS: ENERGY CORRIDOR TO THE NATION

The Department of Energy's (DOE) Strategic Petroleum Reserve (SPR)

Part 2 of 7

by

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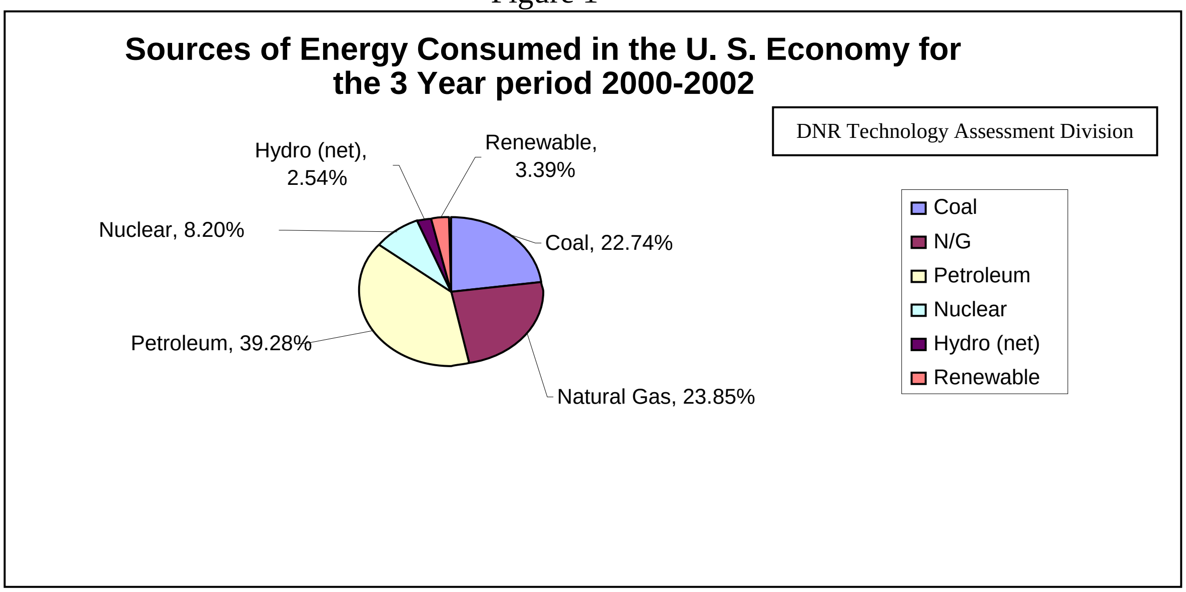
The U. S. uses energy to leverage its physical and intellectual capabilities to raise living standards. Nearly 63% of that energy comes from crude oil and natural gas. These two fossil fuels, especially crude oil, have dominated the energy supply equation for the U. S. economy, not only in the past 100 years, but likely into the foreseeable future.

Figure 1



The importance of crude oil imports to the U. S. economy becomes quite clear from the American Petroleum Institute (API) data tracing historical crude oil production and imports. Over 56% of America's supply of crude oil now comes from foreign imports (Figure 2). With this magnitude of import reliance, the need for a strategic reserve of crude oil supply as a hedge against supply disruptions which could destabilize the U. S. economy is readily apparent.

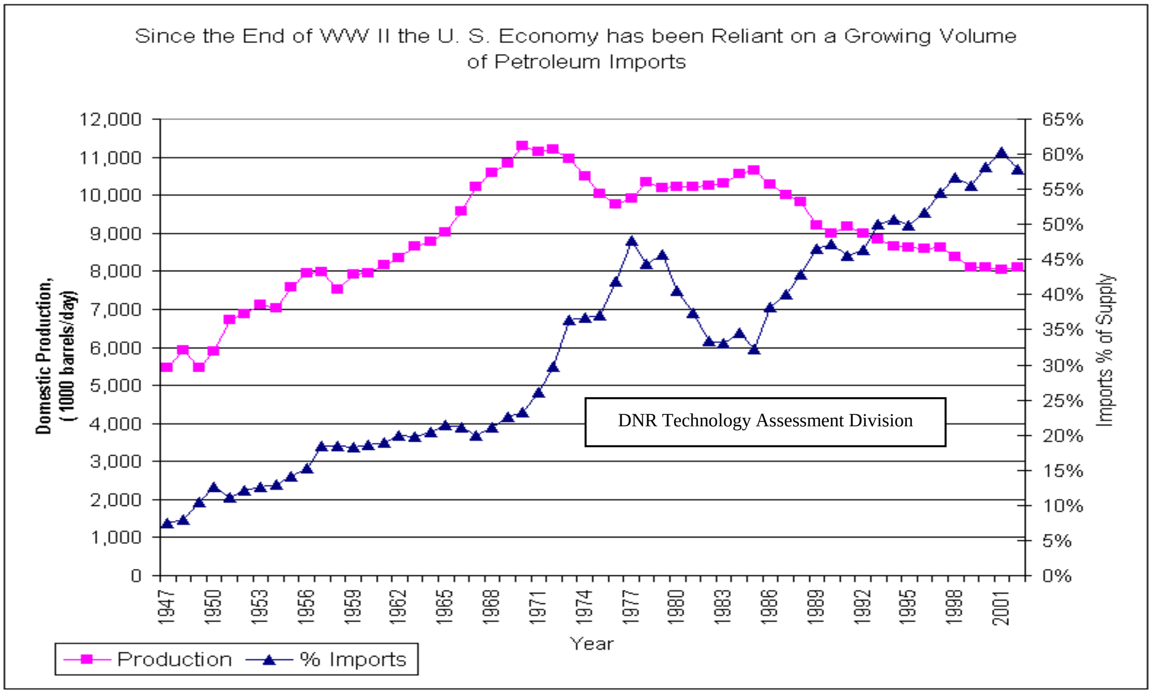
History of Strategic Oil Reserve Policy Discussions

The DOE web site, *Fossil.Energy.gov*, details the history of policy discussions within Administrations since 1944 and is the primary source for a wealth of knowledge about the SPR.

> "Secretary of the Interior Harold Ickes advocated the stockpiling of emergency crude oil in 1944. President Truman's Minerals Policy Commission proposed a strategic oil supply in 1952. President Eisenhower suggested an oil reserve after the 1956 Suez Crisis. The Cabinet Task Force on Oil Import Control recommended a similar reserve in 1970."

But the Arab oil embargo of 1973-74 triggered action. President Ford signed the Energy Policy and Conservation Act (EPCA) on December 22, 1975. This legislation declared it to be the policy of the United States to establish a reserve of up to 1 billion barrels of petroleum.

Figure 2



Louisiana's Wetlands Energy Resources

Because of the existence of a concentration of refineries and distribution points for tankers, barges, and pipelines along the Gulf of Mexico it was logical to look for storage in this geographic area. A large number of subsurface salt domes were identified across Louisiana, Texas, and Mississippi. The subsurface storage of crude oil in salt caverns offered the best security for the Strategic Petroleum Reserve (SPR), low environmental risk, and also the least costly storage mechanism, as salt dome storage is considered about one-tenth the cost of surface storage of crude oil.

Storage locations along the Gulf Coast in Louisiana and Texas were selected because they provided the most flexible means for connecting the SPR storage sites to the existing commercial pipeline and waterways network, subsequently reaching over 50% of the nation's refineries.

In April 1977, the government acquired several existing salt caverns to serve as the first storage sites. Sites were acquired at 3 locations: Bayou Choctaw, near St. James, Louisiana; West Hackberry, near Hackberry, Louisiana; and Bryan Mound, near Freeport, Texas. In 1982, a fourth complex was added, the Big Hill Storage site near Nederland, Texas. Surface facility construction at Bayou Choctaw and St. James, Louisiana began in June 1977. On July 21, 1977, the first oil was delivered to the SPR, a shipment of Saudi Light crude.

The SPR, currently, has 62 caverns for storage of the SPR crude oil reserve. These salt caverns range between 6 and 30 million barrels in capacity. A typical cavern contains 10 million barrels, is cylindrical in shape, has a diameter of about 200 feet, and a height of about 2,000 feet. The caverns are created by drilling into the salt dome, then circulating fresh water to dissolve the desired cylindrical shape.

President Bush has authorized filling the reserve up to its current capacity of 700 million barrels. The SPR is currently receiving oil and will reach that storage capacity by the 4th Quarter of calendar year 2005. Currently, there are 618.4 million barrels of crude oil in SPR inventory. The priority in managing the SPR, under the direction of the Office of Fossil Fuels, is to maintain the readiness of the oil stockpile for emergency use at the President's direction. The current maximum draw down rate is 4.35 million barrels per day.

The St. James, Louisiana Marine Terminal

Surface facilities for oil cargo handling were also needed to sustain the ongoing operation of the subsurface salt dome storage facilities. DOE constructed a marine terminal site in St. James, Louisiana, St. James Parish at mile marker 158.3 on the Mississippi River, approximately, 45 miles west of New Orleans and 30 miles southeast of Baton Rouge, Louisiana. Marine site construction began in 1978 and was completed in 1980. The facilities comprise 2 main sites: "a main terminal occupying, approximately, 105 acres of land, and 2 marine docks occupying, approximately, 48 acres of land."

"The main terminal consists of 6 surface storage tanks totaling 2,000,000 barrels of capacity, crude oil pumping stations, metering stations, and control and maintenance facilities.

Each marine dock is capable of berthing up to 123,000 Dead Weight Ton (DWT) vessels. Vessel loading or unloading is at the rate of 40,000 barrels per hour at pressures from 50-150 pounds per square inch gauge (psig). Oil Barges may also be loaded at Dock 1 at rates ranging from 3,000 barrels per hour to an 8,000 barrel per hour rate.

These surface facilities also have their own award winning, trained fire fighting crews and fire protection system. Likewise, each of the dock platforms has been designed to contain a 666-barrel oil spill before overflowing. Additional containment equipment stored at the terminal includes, approximately, 2,000 feet of containment boom, and several boats for immediate spill boom deployment and oil spill containment.

SPR: From Louisiana's Wetlands to Wall Street

The Strategic Petroleum Reserve (SPR) is now 25 years old (1978 - 2003). Current capital improvements will extend the operating life to the year 2025.

SPR staff benchmark their operation against similar international facilities. The SPR is the lowest cost operation of its kind in the world.

Cost Categories	Cost Range
Storage Development Cost	\$4.50 - \$5.00/barrel (bbl)
Operating Costs	\$0.205/bbl
Drawdown Costs	\$0.15/bbl

Not only does the Department of Energy (DOE) SPR staff maintain efficient economic operations, but their environmental record has earned award winning performance. Each site has an emergency response team equipped to respond should an emergency situation develop.

DOE's SPR is a responsible operator in Louisiana's Wetlands. This is yet another example of the successful coexistence of oil and gas operations within a sensitive environmental setting while complying with State laws and regulations.

This successful coexistence then facilitates a crucial consumer service: a price discovery mechanism for Wall Street which further facilitates least cost delivery of energy products to America's Consumers.

A most important role for the St. James terminal location, and associated pipeline intersections, is in representing the standards for two forms of Futures contracts in crude oil: (1) St. James Light Sweet Crude Oil, and (2) Mars Sour Crude Oil. Both of these are reference contracts on the New York Mercantile Exchange (NYMEX). [For further information on this Futures market reference see Part 3 of this 7 Part series].

The current SPR inventory by type of crude oil, as of September 8, 2003, was:

Sweet	233.8 million barrels
Sour	384.6 million barrels
Total	618.4 million barrels

NOTE: The Department of Natural Resources wishes to thank the Department of Energy for its cooperation in assembling this part of our 7 part series. We would especially like to thank the retired Deputy Assistant Secretary for Petroleum Reserves, Richard Furiga and Director of Planning and Engineering, Dave Johnson, of Washington, D. C.; Special Assistant to the SPR Project Manager, Ann Rochon, Director, Crude Oil, Drawdown Readiness, and Cavern Integrity Division, Nabil Shourbaji, and Petroleum Engineer, Robert Myers, all from the New Orleans office; and to the Research Librarians at the State Library of Louisiana.

SELECTED LOUISIANA ENERGY STATISTICS

Among the 50 states, Louisiana's rankings (in 2002 unless otherwise indicated) were:

PRIMARY ENERGY PRODUCTION
(Including Louisiana OCS)
1st in crude oil
2nd in natural gas
2nd in total energy

PRIMARY ENERGY PRODUCTION
(Excluding Louisiana OCS)
4th in natural gas
4th in crude oil
8th in total energy

REFINING AND PETROCHEMICALS
2nd in refining capacity
2nd in primary petrochemical production

ENERGY CONSUMPTION (2001)
3rd in industrial energy
3rd in per capita energy
3rd in natural gas
5th in petroleum
8th in total energy
22nd in residential energy

A Hydrogen Primer

by

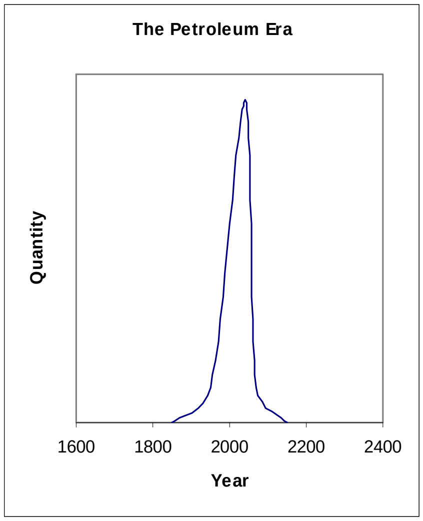
Bryan Crouch, P.E.

The End of Cheap Oil

Energy is inextricably linked to our society and economy. We use energy as leverage for our physical strength and intellect to perform tasks we could not otherwise accomplish. Almost everything people do in the course of a day involves, or depends on, a machine using energy to produce work. Not just any energy will do, it must be affordable energy.

It has to be affordable because people are not interested in buying energy; they are interested in buying products and services. If the energy required to create products and services is unaffordable, the products and services become unaffordable. Currently, we get affordable energy from fossil fuels, a finite resource. Of the fossil fuels, oil is the most heavily relied on, but long before we run out of oil, we will run out of cheap oil.

At some point in the future, global oil production will peak and begin to decline. Some time after this, as demand rises and supply declines, prices will rise sharply. Prices will destabilize prior to this due to speculation and anticipation. Finally, prices will increase to a level beyond what the economy can support and the era of cheap oil, that began when Edwin Drake struck oil in 1859, will come to an end.



The world oil production curve will look something like the illustration on the right. The time frame for this sequence of events is the subject of much debate and speculation. The U.S. Department of Energy's Energy Information Administration predicts a peak between 2030 and 2075 (Energy Information Administration, 2000). Other experts on the subject predict a global peak ranging from 2000 to 2015 (Williams, 2003). The point is, whether the global peak occurs now, or 50 years from now, the petroleum era will be a short, finite blip in history.

The Hydrogen Economy

In order to maintain our economy and standard of living beyond the petroleum era, we will have to transition to some other energy regime. One possibility is hydrogen.

In 2002, the U.S/ Department of Energy released the National Hydrogen Energy Roadmap, and in 2003, President Bush announced $1.7 billion in funding for hydrogen energy in the State of the Union Address. Hydrogen has received a lot of attention lately, some portraying it as the cure-all for our energy problems, and some as an attempt to slash funding for research and development of other alternative energy sources.

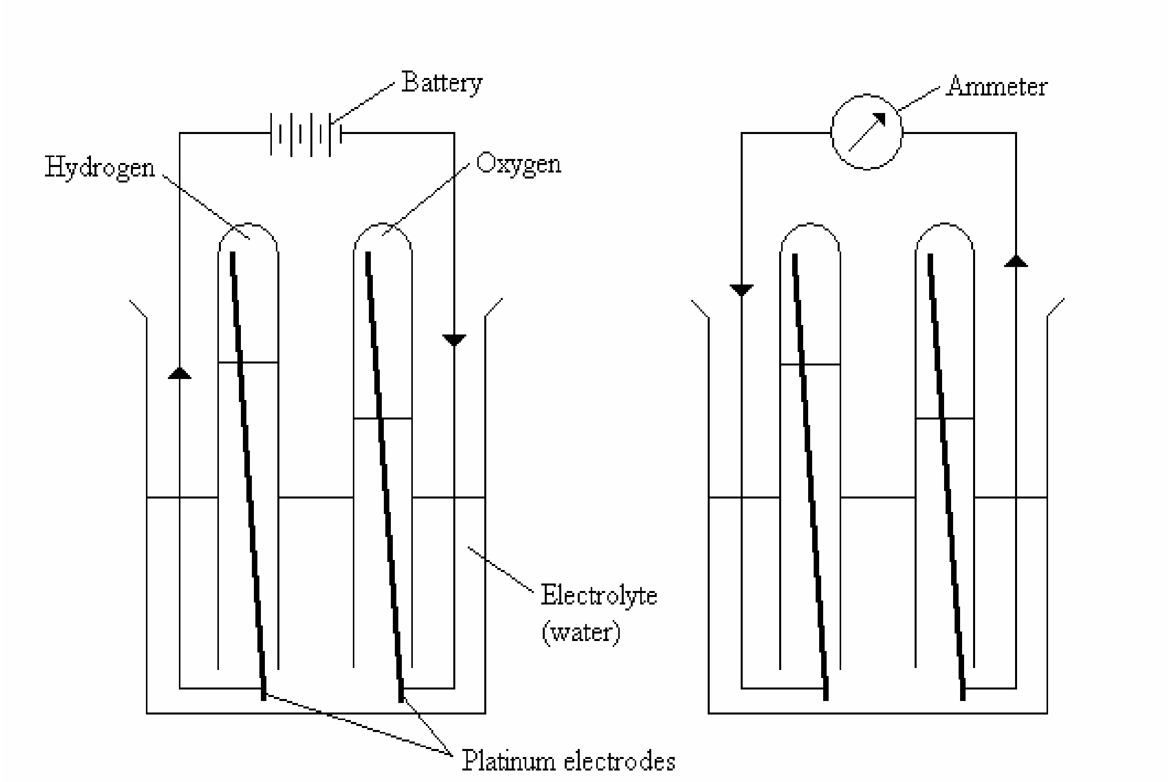
The reasons for the wide ranging characterizations of hydrogen energy, other than political, are due to the fact that, in theory, hydrogen does indeed seem like a miracle solution to many energy problems, but many significant barriers exist to put it into practice. The following is an introduction to hydrogen and some of the possibilities and problems associated with a hydrogen based economy.

No one knows, yet, exactly what a hydrogen economy would look like, but the front running scenario would be based on hydrogen fuel cells producing electricity. The electricity would then be used to power vehicles, homes, businesses, etc. In this scenario, hydrogen is not an energy source, but rather a carrier. Hydrogen can, also, simply be used as a combustion fuel in an internal combustion engine. The only emission is pure water. Ford and BMW are actively pursuing this option as an alternative motor vehicle fuel.

Fuel Cells

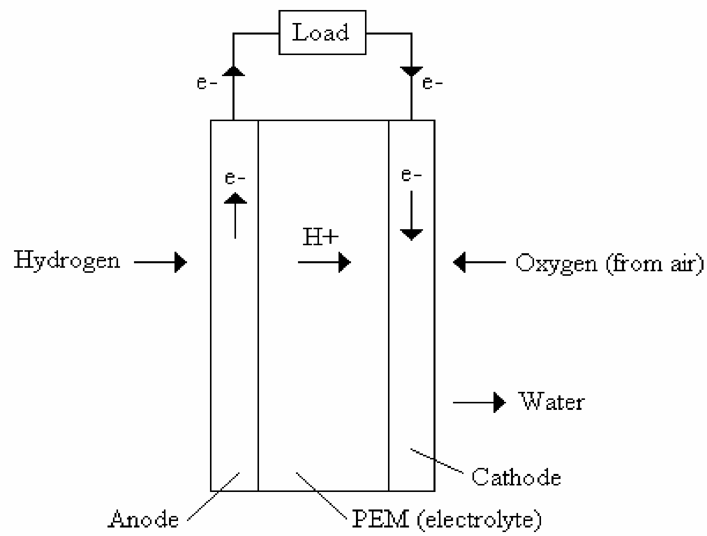
A hydrogen fuel cell is a simple device that uses hydrogen and oxygen to produce an electric current. Sir William Grove is credited with the discovery of the fuel cell in 1839. His experiment was based on the known fact that, if an electric current was applied to water, it would separate into its constituents, hydrogen and oxygen (Figure 1). Grove's experiment simply showed that, if the electric current was removed, the reaction would reverse, and the hydrogen and oxygen would recombine into water and produce an electric current (Figure 2).

Figure 1 **Figure 2**



A practical fuel cell is more complex than the one shown in Figure 2, although the operating principle remains the same. One of the simplest types of a hydrogen fuel cell is the proton exchange membrane (PEM) fuel cell. A PEM is a specially designed polymer that functions as the electrolyte in the fuel cell assembly. The basic components of a PEM fuel cell are shown in Figure 3. Basically, a PEM fuel cell operates as follows: Hydrogen is fed to the anode and separated into hydrogen ions (protons) and electrons. The PEM allows the hydrogen ions to pass through to the cathode, but not the electrons. The electrons are given a separate path to the cathode, enabling electrical energy to be extracted. Oxygen is supplied to the cathode which combines with the hydrogen ions and electrons to form water. Another way of understanding the operation of a fuel cell is to think of the hydrogen as being "combusted," or oxidized, but, instead of producing heat energy, the reaction produces electrical energy. The voltage produced from this reaction is small, less than one volt. For this reason, several cells are connected in series, called a fuel cell stack, to produce the desired voltage. A typical PEM fuel cell is about 50% efficient, that is, it converts 50% of the energy contained in hydrogen into electricity. The efficiency can be increased substantially by capturing the waste heat and using it for space heating, water heating, or process heat. When the waste heat is utilized in a cogeneration setup, efficiencies can reach 90%.

Figure 3



Hydrogen Production and Transportation

The good news about utilizing hydrogen as an energy carrier is its abundance and its environmental benefits. The bad news is that it is always chemically bound to something else, usually oxygen and carbon. In order to obtain hydrogen, energy has to be exerted to break its chemical bonds with other elements. In general, with current technology, the energy required to obtain hydrogen renders the process uneconomical. While fuel cells have their own set of significant obstacles to overcome before being technologically and economically viable, the problems associated with obtaining and distributing hydrogen are generally thought to be more difficult to solve.

The ultimate objectives of hydrogen production for use as an energy carrier are producing it economically and renewably. There are several ways to produce hydrogen, some of them economical, and some of them renewable, but none that are both, as yet.

Over 9 million tons of hydrogen is produced yearly in the U.S. Most of it is used to make ammonia, while other users include refining, chemical, and food industries. Ninety five percent of this hydrogen is produced by using steam to reform natural gas (fossil fuels contain lots of hydrogen). This method can be economic, depending on the price of natural gas, but natural gas will eventually suffer a fate similar to that of oil since steam reformation of natural gas is a non-renewable source of hydrogen.

Renewable hydrogen production is accomplished by using renewable generated electricity (solar, wind, etc.) to perform electrolysis on water. Electrolysis, whether using renewable or non-renewable electricity, is inefficient, usually making it uneconomic. There are other ways of obtaining hydrogen including thermal water splitting, thermochemical water splitting, gasification of coal, and thermal and biological conversion of biomass. All of these methods are being investigated to determine their economic and technical feasibility.

The other major problem associated with hydrogen is transportation. Hydrogen gas is extremely lightweight, making it necessary to compress or liquefy it in order to be contained in a reasonably sized volume for transportation by ship or truck. This adds considerably to the cost. Hydrogen can be transported effectively by pipeline, but few dedicated hydrogen pipelines currently exist. In the beginning stages, hydrogen will have to be produced on or near site. As hydrogen usage expands, the economics will change and, depending on technological advances, central hydrogen production may make sense.

Transition and the Future

This discussion, so far, focuses on the current state of hydrogen in relation to its use as an energy carrier. It's clear that a hydrogen based energy regime will have to begin with the non-renewable production of hydrogen for economic reasons. As the transition to a new energy regime occurs, the technology and economics will change, hopefully leading to the economic, renewable production of hydrogen. For example, hydrogen will accelerate the development of wind and solar power by enabling the storage of energy produced by these intermittent sources. This would allow wind and solar to move into geographic areas that are not, otherwise, ideal for their usage. Another renewable technology that may mesh well with hydrogen is off shore geothermal electricity generation. This technology uses the temperature difference in water depth to drive a thermodynamic cycle and generate electricity. Although the process is extremely inefficient, the size of the resource is huge, including all tropical oceans and the Gulf of Mexico. The electricity can then be used to electrolyze sea water to produce hydrogen, which is then liquefied and shipped to shore for distribution.

The Louisiana Connection

Whether or not hydrogen proves to be the foundation of future energy production, a lot of resources are being directed towards hydrogen and fuel cell development. Louisiana is one of the few places in the country that has an existing hydrogen infrastructure. Air Liquide, Air Products, and Praxair operate hydrogen pipelines in Louisiana, and Louisiana is home to many chemical plants and refineries that produce and use hydrogen. The existence of this hydrogen market creates a ripe environment for hydrogen and fuel cell development. If taken advantage of, Louisiana could become a hub of hydrogen and fuel cell development. For example, in the largest fuel cell transaction to date, Dow Chemical and General Motors recently announced a deal in which GM will provide fuel cells to the Dow plant in Freeport, Texas. Dow will use excess hydrogen generated as a byproduct from chlorine production to feed the fuel cells. The electricity generated by the fuel cells will be used for general power in the plant. The fuel cells are expected to produce 35 megawatts of power over the life of the project. Dow and GM are discussing plans for similar projects at other Dow plants.

We will still be using fossil fuels well into the future, but, eventually we'll have to derive energy from some other source. A lot will be at stake for Louisiana when this happens. Everyone knows what would happen to Louisiana's economy if the oil and gas industry weren't here. If electricity produced via hydrogen turns out to be the alternative, and we take advantage of the opportunity, Louisiana could continue its role as a leader in energy production and technology well into the future.

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